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THE J. J. HEATLEY COMPANY

BOX 284

SMITHTOWN, N. Y.

ADMINISTRATIVE FILE

Heatley J. J. Company

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August 22, 1957

International Brotherhood of Teamsters
Washington,
D.C.

Gentlemen:

Some time ago I had occasion to prepare for one of the larger scale manufacturing companies a report on electronic truck scales. These are the new units appearing in a number of states that weigh trucks while they are in motion, and detect overloaded axles at speeds up to 60 miles per hour.

Such units are now in limited use in Virginia, Minnesota, Connecticut, Iowa and Oregon. As the Interstate Highway System progresses it is my confident feeling that these units will gradually be used in all states.

The equipment is not hazardous to truck drivers, and yet there have been times when drivers have slammed on the brakes approaching one of these roadway platforms and the consequences could have been serious under slightly different circumstances. The drivers should know of this equipment - should be able to identify the various types of electronic scale platforms, and be instructed in how they should be approached.

A copy of the report is enclosed for your review. I have about 900 copies remaining, and felt you might want to distribute them to your members as part of a driver education or safety program. They would come to about \$.35 each.

Please let me know soon as I have several other possibilities for disposing of the material. Thanks.

Very truly yours,

James J. Heatley
Truck Scale Consultant

Truck Motion Weighing
Report
T-38

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TRUCK MOTION WEIGHING REPORT T-38

General

Electronic weighing is not new! For 14 years this technique has been used to weigh aircraft, with Federal approval. Electronic aircraft weighing kits, manufactured by Cox and Stevens electronic Scales have become the accepted means of obtaining aircraft weights in the USAF, RAAF, RCAF and by all commercial airlines. Approximately 90% of all heavier aircraft throughout the world have their weights controlled electronically.....to 1/10th percent guaranteed accuracy.

And, the trucking industry is not the first to experience motion weighing. This again is not a new mysterious technique. Freight cars in railroad hump yards have been weighed accurately in motion by electronic means since 1948. Again Cox and Stevens were the pioneers in this field, and the Pennsylvania Railroad the first user.

Freight cars in motion however present a far simpler technical problem in weighing accurately than do trucks speeding down the highway. Freight cars travel at relatively slow speeds, body vibration is at a minimum, and their position on the scale is easily forecast. Such ideal conditions do not prevail on the highways. There the problem of weighing in motion becomes much more complex and the approach to acceptable accuracy more precarious.

The Electronic Highway Scale

At the present time there are two types of highway weighing being practiced. Both are of relatively recent development and much more refinement and more widespread use may be expected in the years and months to come.

First, a research unit has been developed for the purpose of collecting axle and gross weight data for highway design purposes. There is no enforcement involved in the operation of this type equipment. The information gained is used by the state highway departments and also is forwarded by them to the Bureau of Public Roads in Washington for study purposes. Use of the electronic equipment in this instance

will replace those 6 man crews using the loadometer wheel scales that periodically stopped a sampling of the truck traffic for weighing purposes by the side of the road.

Second, an overload detection unit which weighs for the purpose of enforcing the state legal axle load limits with the truck in motion. At present stages of refinement, accuracy achieved by this means is not sufficient to hold up in court for violation conviction. Consequently these units are always used in conjunction with and located relatively near a static weigh station.

General Electronic Scale Information

An electronic scale for weighing motor trucks, either stationary or moving, consists of three major components:

1. The roadway pit and platform
2. The pit electronic equipment
3. The indicator/recorder

As a vehicle passes over the platform, the axle weight is impressed on four weighing cells, or "load cells" that support the platform from underneath at its four corners. The momentary weight impression causes the load cells to slightly compress, generating a voltage output which is transmitted to the indicator by electric cable. This voltage output is directly proportional to the weight on the platform. The indicator reads this voltage in terms of "pounds" instantaneously!

The platform in the roadway, for either the research or the detector unit, extends the width of one lane....usually 11'. In the direction of traffic, the platform length is:-

- 3' for the research unit..... (3'x 11')
- 7' for the detector unit..... (7'x 11')

See Figure 7, Plate 3 for load cell picture. This small important component is but 3" high and 2 3/4" in diameter yet has the ability to accurately weigh loads from zero to 50,000 pounds. Its own weight is about 3 pounds!

The indicator, whether it be for motion research weighing, or for overload detection may be located as far as 200 ft. from the platform. The overload detector indicator is pole mounted as shown in Figure 6, Plate 2, and usually immediately ad-

jaacent to its platform. No operator or attendant is necessary for proper operation of the overload detector. The research unit on the other hand is usually remotely located and requires an operator.

The tendency now in the planning of a number of state highway departments is to mount the research indicator in a station wagon or bus and to travel from one platform location to another simply plugging-in the indicator for their research readings on a temporary basis. So, research motion weighing work may be identified by two features, (1) the presence of an operator in station wagon or bus, and (2) the narrow platform (3'x 11').

Note: There is one exception to this generalization. On the southbound toll lane on the Delaware Memorial Bridge the Teller and Cooper Company is experimenting with a 30"x 11' single axle overload detector. At present writing this is not yet in official operation.

The Overload Detector Operation

Present practice is to locate overload detectors about 1000' ahead of a static weight station. The purpose is to "cull out" of the traffic all the trucks whose single or tandem axles exceed the allowable state weights. These trucks are then directed by an automatic electric sign (coupled to the overload detector) into the weighing station for weighing in the normal accepted fashion. Those trucks well within the legal load limits would be advised by this same electric sign to "not stop" at the weighing station.

See Figure 3 Plate 2 for sign configuration. When the overload detector is tripped the sign will illuminate in the following manner:

ENTER

WEIGH STATION

with the letters and the right hand arrow in bright red. Axles checked that are within the legal limit will instantaneously cause the sign to read:-

DO NOT

ENTER

WEIGH STATION

with lettering and the left hand arrow in bright green. That portion of the sign saying "TRUCKS ONLY" remains on all the time and is amber in color.

Considerable experimentation with the intensity of the sign light was necessary since when facing the sun, the first sign installation at Woodbridge Virginia was difficult to see. The manufacturer, the Link-O-Matic Signal Company, claims now this has been corrected.

There are a number of problems that face the operators and manufacturers of this overload detection system. Vibration, lateral wheel placement, speed, axle suspension types, and the weather all contribute their share of inaccuracy.

Vibration

As a trailer, semi or full, travels down the road any road surface unevenness or bumps will cause the springs to vibrate. This vibration is transmitted to the trailer and its cargo. On the "upswing" of the vibration the wheel loads are less! On the "downswing" they become heavier! For example, an axle may weigh statically (standing still) 7,000 pounds but when the truck is underway with moderate vibration introduced it may weigh as much as 10,000 pounds at the low vibration point, or as little as 5,000 pounds at the end of the upswing vibration point. With dual axles this difference is multiplied.

This causes trouble for the detector as well as the drivers.

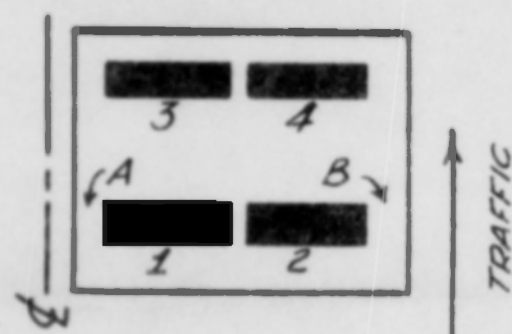
If your truck is well within the legal limit statically..... and the truck crosses the platform while vibrating....the axles may easily exceed the legal limit at that instant and trip the detector.

Speed induces vibration, and the higher the speed the "longer" this vibration persists. So, as a rule of thumb, always cross a detector platform as slowly as possible for a fair deal.

Lateral Placement

The lateral position of the axle wheels on the platform will not cause any variance of the weight indication....as long as all wheels are ON the platform. The split treads in the

platform surface are designed to cause the overload detector to trip (even if the axle weights are well within the legal limits) if side by side treadles are not tripped simultaneously.



If a truck partially swings into the inside lane and only treadle contacts 1 and 3 are closed, the sign will automatically light up for an overloaded vehicle. Similarly if the truck ventures to by pass the platform partially by taking to the shoulder and only treadle contacts 2 and 4 are closed.

AND, there is not enough space along either edge of the platform so that the outside wheel of a dual could ride past the platform on the foundation. Space has been designed along the edge (A and B) so that if the outside wheel is off the platform, the inner wheel will not trigger the treadle, so the detector will act as if the axle were overloaded!

In brief then, an overload indication cannot be avoided by straddling the platform and the adjacent lane. The only way to beat the system is to miss the platform 100% which is a violation in itself.

Speed

Speed prolongs vibration distance-wise! Vibration causes "heavier" than static weights. Therefore overload detector platforms should be crossed as slowly as practical. The instrument manufacturer recommends a 100 ft. smooth slab of concrete for the approach to any detector platform. By moving slowly through this 100' any serious trailer vibration will tend to dampen out. This procedure will make an overload indication much less likely if the axle weights are within or close to the legal limit.

Suspension Systems

Extensive tests by the manufacturer at the Bureau of Public

roads test installation at Woodbridge, Virginia failed to uncover any marked differences in overload detection caused by the type of bogie suspension.

Theoretically, any type suspension system that reduces the amount or amplitude of vibration should contribute to less error. Rigid suspension (no springs) such as those on the rear of many low bed trailers should provide the closest motion weight readings when compared to weights taken statically. This however did not prove out conclusively during test.

Summary

Briefly the facts on overload detection in motion are:-

1. Platforms should be approached slowly to give vibration a chance to dampen out.
2. Either axles must be 100% on the platform or it must be missed completely. Any partial weights will cause the instrument to trigger automatically.
3. Sudden acceleration or deceleration should be avoided in crossing the platform. Respectively this will increase the rear axle loads and the front axle loads by several thousand pounds in severe cases.
4. The large "flat plate" area on the front of a semi will cause a heavier rear axle by up to 750 pounds in gusty wind. The amount of error is proportional to speed. This is relatively minor in the face of other induced errors.

Acceleration and Deceleration

Acceleration increases the load on the rear axles. Deceleration increases the load on the tractor drive axles. For a lower weight indication all around.....an alert driver could accelerate while the tractor axles were crossing the platform.....and decelerate (brake) while the semi's dual axles were on the platform. It would be possible in this fashion to register a lower weight by about 1000 pounds on each of the important axles. Actually the safest practice still is to coast across the platform at slow speed!

Double Check

Each time an axle trips the detector, the sign flashes the truck into the weigh station.

How do the weigh station people know whether the sign flashed red or green if it is located 1000 ft. away and facing the opposite direction? Why not breeze right on past the station regardless of what the sign says? Will they know any different?

Each time the detector is tripped by a heavy axle, a RED signal light flashes in the weigh station to advise the weighmaster he may expect a truck to stop shortly. If the truck goes by without stopping he will jot down the operators name and truck number for police follow-up. Also, each time the detector is tripped a mechanical counter in the instrument cabinet adds a number. At the days end the weighmaster will check the number of trucks he actually weighed against the number on the counter to see whether any trucks "went by". If there is a discrepancy he will notify the state police and they will then "cover" the detector platform for a period of time.

OVERLOAD DETECTOR INSTALLATIONS

Virginia

Location Woodbridge, U.S. Route 1, northbound lane. Test installation for the Bureau of Public Roads and the Virginia State Highway Department for proving out the detection system as a prelude to adding others throughout the state. Road conditions are smooth and the platform is smooth. The research unit is sometimes tested at this location using the large platform. Unit has never been in official operation but this could be started any day. Recommended speed 20 miles per hr. in crossing the platform. Installation follows layout shown in Figure 2, Plate 1 without treadle A. For exact location see map on Plate 3. Instrumentation is on embankment beside platform in white shack.

Minnesota

(a) Route 12, St. Louis Park, Minneapolis. Platform is 7'x 11' in westbound outside lane about 2000' east of static weigh station. Road and platform conditions generally smooth. Recommended speed 20 miles per hour. Layout similar to Figure 2 Plate 1. Installation picture same as that shown in Figure 2 Plate 2. For map location see Plate 3.

Caution: The inside lane of the highway must be crossed to get into the weigh station and the distance is relatively short. Be careful of following traffic.

(b) Route 100, St. Louis Park, Minneapolis. Platform 7'x 11' in southbound outside lane. Location about 1½ miles from the static weigh station on Route 12 (a). Offending trucks are supposed to observe automatic sign and turn west on Route 12 to weigh station. Road conditions are very rough both on the approach surface and across the platform. Speeds of 10 miles per hour are suggested. This installation will be watched frequently by the state highway patrol, because of its distance from the weigh station....and because of the obvious temptation on the part of the drivers to ignore the sign and continue south. Platform layout similar to Figure 2, Plate 1 without road tubes. Looks like the one shown in Figure 6, Plate 2 except the road is asphalt.

(c) Route 12, east of St. Paul near Minnesota Mining Research Building. Platform is 7'x 11' in westbound outside lane and is pictured specifically in Figure 6, Plate 2. Road and platform conditions only fair. Recommended speed 15/20 miles per hour.

Caution: The inside lane must be crossed into the weigh station and automobile traffic is moving fast at this location.

The Minnesota sign is temporary and merely states automatically

GO

TO

SCALE

with white letters on a yellow background. It is difficult to read and it is expected that the design will be changed to that used in Virginia soon.

Connecticut

On Route 5 midway between Wallingford and Meriden. Platform is 7'x 11' in the northbound outside lane. Recommended speed 15 to 20 mile per hour. So far this has been the manufacturers experimental installation however the state police are showing considerable interest and plan two similar installations at Fairfield and Stratford on the new GK Expressway. The static weigh scale on the Expressway will be located at Westport. No sign at this location! Installation similar to that shown in Figure 6, Plate 2.

Note: This installation may be changed in appearance from time

to time because of development work by the manufacturer. Road tubes may be out for test work on the research unit.

General.....Overload Detectors

To date no effort has been made to offer a weight taken in motion in court as evidence of a weight violation. To date Detectors are used only in conjunction with weigh stations.

No operation yet (other than the IBM Ohio Turnpike installations) add axle weights in order to check the gross weights. This is possible with present day electronic techniques so it is only a matter of a short time before this extra component will be offered.

Treadle A in Figure 2 is a manufacturers afterthought. Originally treadle systems A and B were all that were thought necessary to distinguish between single and dual axles...however it was found that not enough time on platform was available to properly detect overloaded tandem axles. Thus the additional treadle ahead was recommended. This actually obsoletes treadle C but on a number of installations it still remains.

The Teller and Cooper Company have the contract for toll station equipment on the Indiana Turnpike. The contract calls for overload detectors. The only evidence of appearance and operation of this manufacturers unit so far is the one mentioned on the Delaware Memorial Bridge. Only 30" in length it is able to check single axles and not tandems.

MOTION WEIGHING FOR RESEARCH

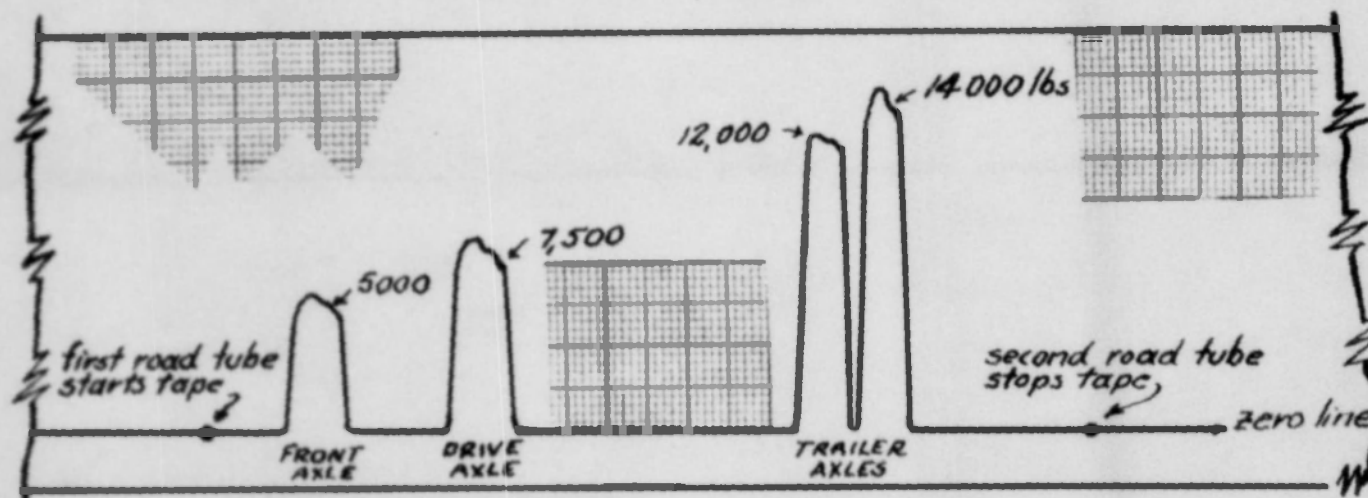
This new electronic research equipment touched upon previously in this report is beginning to take the place of the "loadometer survey crews". It is much more efficient! Easily operated by one man, 100% of the truck traffic may be weighed within a given period. This compares with a crew of 6 weighing a 10% sample of the truck traffic. This equipment is identified by the 3'x 11' platform, a road tube 10' ahead of the platform, and another road tube 50' beyond the platform. Axle weights are recorded on a graph tape which emerges through the left side of the cabinet facing the instrument. The spacing of the road tubes enables the calculation of speed, and axle spacing.

The platform in the roadway is the permanent part of the installation. See diagram Figure 1, Plate 1. The indicator/recorder may be moved from one platform location to another.

It is normally carried in a station wagon.

Four electronic load cells support this platform in a manner similar to the overload detectors. A junction box by the side of the road enables the operator to "plug in".

Traces of the axle weights on the tape are as below.



Accuracy in this particular type of motion weighing is not as important as in axle weight "enforcement" operations. Single axles and tandems are usually recorded to within 3 to 5% of the static weight.....however by summing the individual axles an accuracy of about 1% is possible on gross weights. Speeds and axle spacing of trucks in motion calculated from the tape are quite accurate.

The road tubes ahead and beyond the platform (1 and 2 in Fig. 1, Plate 1) respectively start and stop the tape through the machine automatically. As yet there is no way to keep automobiles from starting the tape so this is the reason why an operator is necessary. He merely keeps the instrument in "stand-by" condition until a truck approaches.

The research unit may also be connected to the overload detector platform. However, the research unit and overload detector cannot be operated from the same platform simultaneously. It must be one or the other!

Present Installations

Shirley Highway

About 20 miles south of Washington, D.C. and 1500' north of the intersection at Route 1. The platform is in the outside

southbound lane. This installation is now obsolete and no longer is being used. It was the original installation where research was conducted by the Bureau of Public Roads and the manufacturer.

Iowa

Platform located near Tama, Route 30 (Lincoln Highway) in the westbound lane. This is operated periodically during spring, summer, and fall. It is used to check truck weights in both east and west directions. Road blocks are put up in the eastbound lane.

Iowa has ordered nine additional research units for other locations around the state. Installation of the new units will start in late summer 1956 and stretch through 1957. So far there is no plan in Iowa to adapt these platforms to any type of axle load enforcement. The Iowa Highway Department has purchased a used school bus and completely equipped it for this type of weight research work.

Oregon

Two motion research units, located side by side (north & south lanes) on a north south road connecting routes 99W with 99E for the past several years. Recently they have been removed from this location for installation in the new Portland-Salem Freeway. They will be placed midway between the Wilsonville and Woodburn interchanges during the summer of 1956 but will probably not be operated until fall or winter 1956.

Fotopatrol

A new type high speed camera has been developed by a New York group to be competitive with the radar speed meter. The excessive speed is detected by two thin contact strips across the highway lane. The camera shutter is set to "click" at all speeds detected above the speed limit. A 35 mm. negative is made which when developed and printed shows, (a) the speed of the truck or car, (2) the date and time, (3) the rear license plate, and the (4) location of the instrument at that time. An electronic flash is used for a light source. It is claimed to be superior to radar since it "identifies" the violator. This unit is being considered for use with overload detectors to trigger and take a picture of the overloaded truck for identification purposes. This unit may be tested in Minnesota at remote detector locations, to keep drivers from ignoring the sign instructions. Nothing definite on this yet however.

TWO TYPES OF
MOTION WEIGHING PLATFORMS

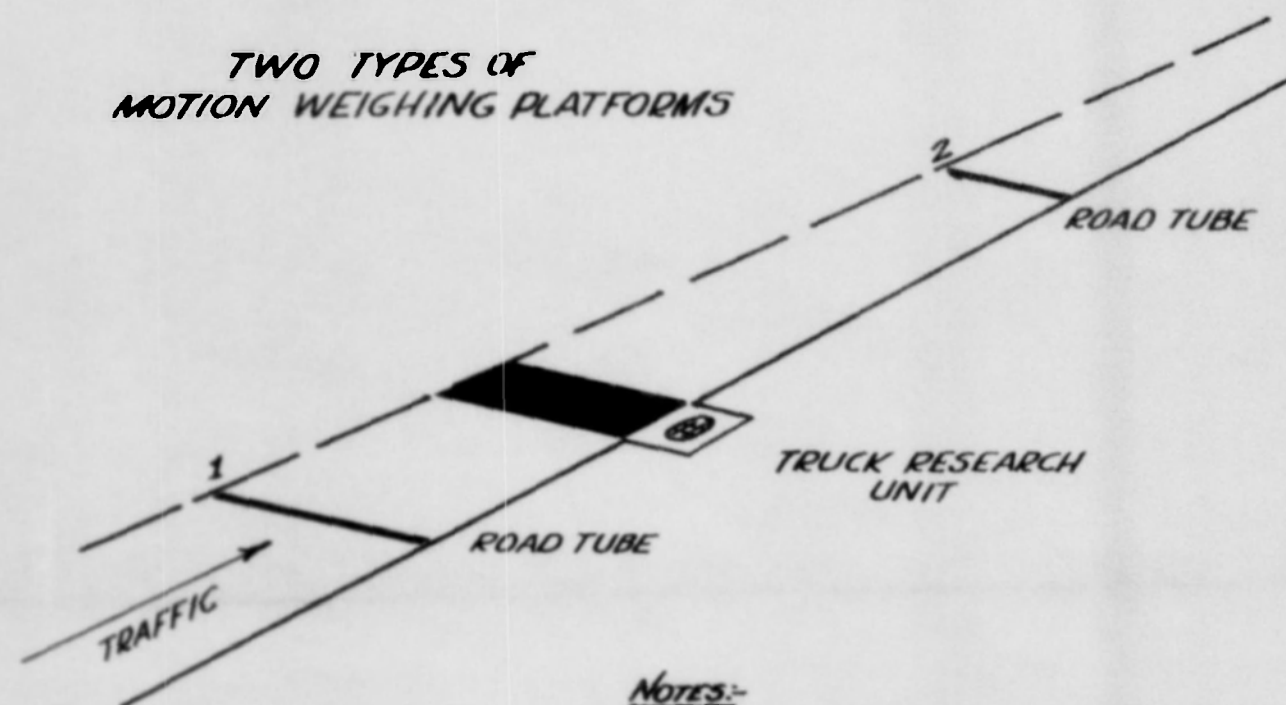


Fig 1

NOTES:-

- (a) Treadle No.1 starts inst. action.
- (b) Treadle No.2 stops inst. action.
- (c) Road $\frac{1}{2}$ covers inside edge of platform.

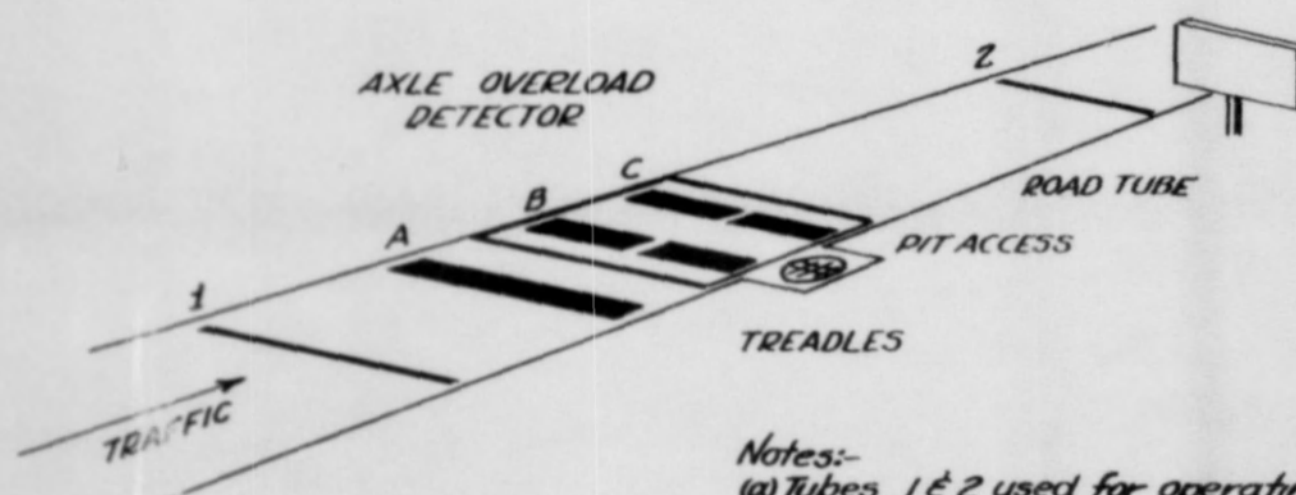


Fig.2

Notes:-

- (a) Tubes 1 & 2 used for operating research unit only.
- (b) Treadle (A) together with set (B) tell inst. whether single or tandems are "ON"
- (c) Split treadles B and C tell whether all axles are on platform.

PLATE 1

FLEET OWNER

HUGHES HILL MAGAZINE OF TRUCKING

TRUCK TRENDS

Reported by FLEET OWNERS

The new electronic highway scale that weighs trucks in motion is now getting a try in Virginia, where the State Highway Department has installed one of these devices near a station on U. S. 1. The scale, which is already in use in several Midwest and Western states, indicates overloaded trucks to weighing officials, who flag these vehicles down. Legally loaded vehicles can keep going. Use of this scale is expected to become widespread in the near future, which will mean smoother traffic flow and better running times.



Fig. 3. Virginia detector sign which will become a standard with the equipment.



Fig. 4. Motion weighing research platform, 3' x 11', used in Iowa & Oregon.



Fig. 5. Research cabinet for recording axle weights in motion with weight, trace, speeds, and axle spacing emerges from left.

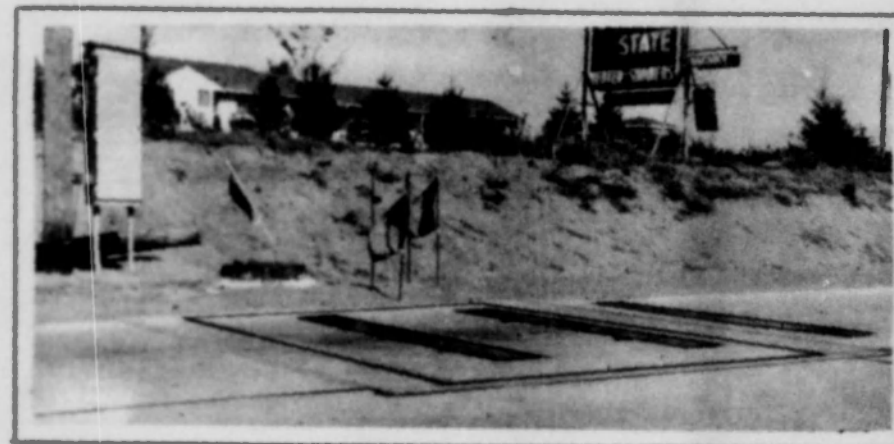


Fig. 6. STD. detector platform for single & dual axles used in Minn., Conn., and Virginia. Note pole cabinet for instrument.

PLATE 2



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FIG. 7 ELECTRONIC LOAD CELL
FOUR UNDER EACH PLATFORM



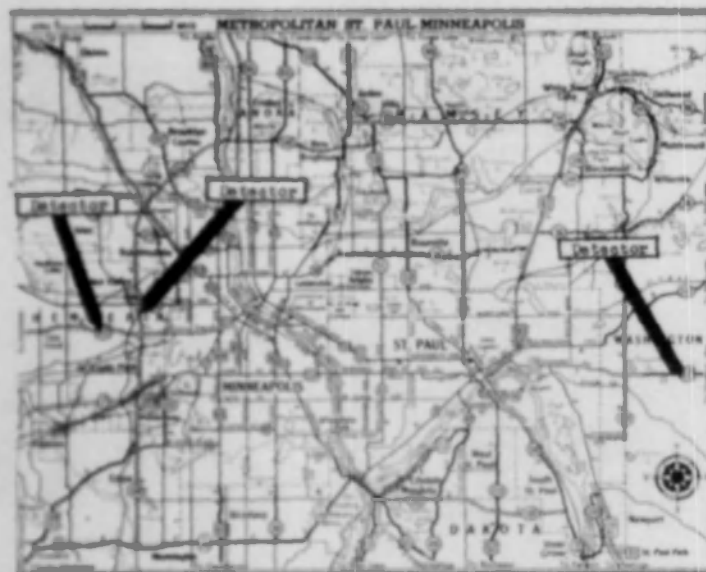
OREGON



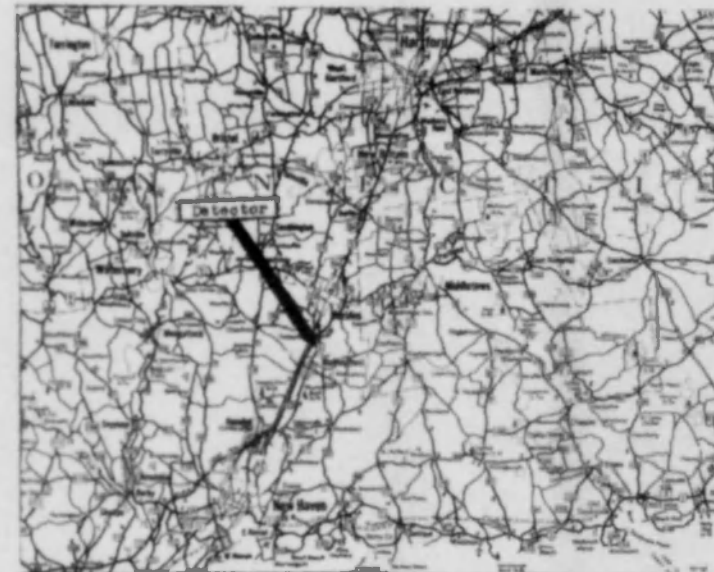
VIRGINIA



IOWA



MINNESOTA



CONN.